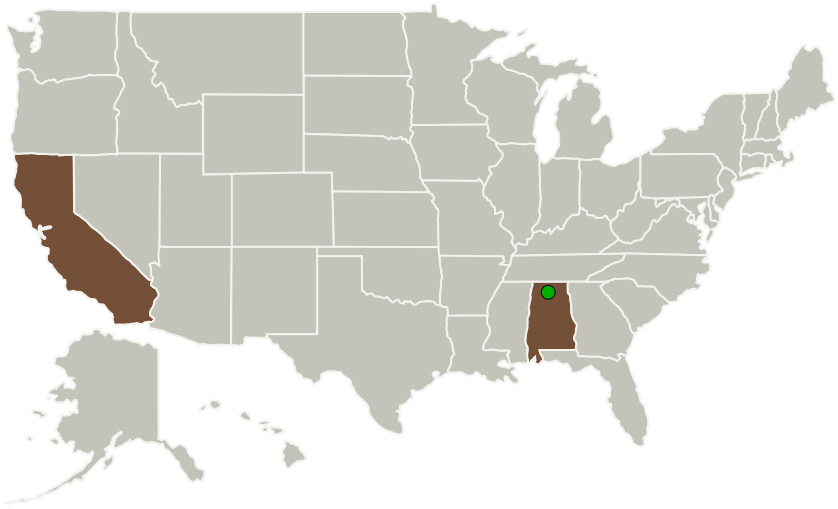
A Massively Parallel Framework for Low-Dissipation, Multiphysics Simulations of Rocket Engines, Phase I

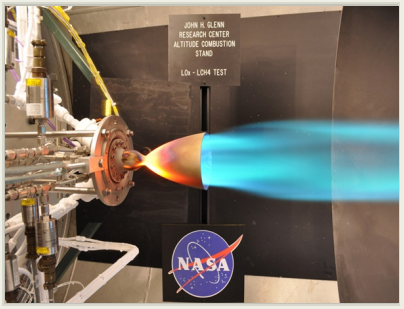
Completed Technology Project (2017 - 2018)

Project Introduction

In this proposal, researchers from Cascade Technologies and Stanford University outline a multi-year research plan to develop large-eddy simulation (LES) tools to predict and understand combustion instabilities in liquid-propellant rocket engines. Rocket instabilities are a notoriously complicated, multiscale problem involving nonlinear interactions between transcritical multiphase flows, turbulent mixing, combustion heat release, and acoustics. Each of these technical areas will be addressed to some extent during the course of the project. Central points of the Phase 1 plan include: adding real-fluid extensions to the open-source chemistry package Cantera, running CFD validation cases at rocket-relevant conditions, assessing the impact of low-dissipation numerical schemes on liquid sprays, and developing a unified multiphase formulation to span subcritical and supercritical conditions. These activities will set the stage for additional model developments and applied rocket simulations in Phase 2. Conclusions from the Phase 1 studies will help prioritize and plan the specific research areas to be addressed during Phase 2.

Primary U.S. Work Locations and Key Partners





A massively parallel framework for low-dissipation, multiphysics simulations of rocket engines, Phase I Briefing Chart Image

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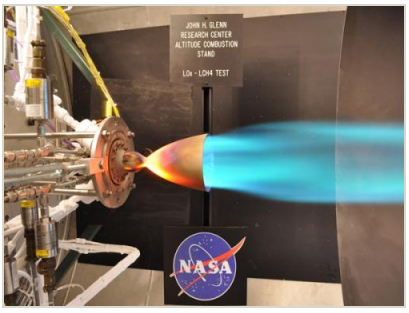
Organizations Performing Work	Role	Type	Location
CASCADE Technologies, Inc.	Lead Organization	Industry	Palo Alto, California
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama
Stanford University(Stanford)	Supporting Organization	Academia	Stanford, California

Primary U.S. Work Locations	
Alabama	California

Images



Briefing Chart Image
A massively parallel framework for low-dissipation, multiphysics simulations of rocket engines, Phase I Briefing Chart Image *(https://techport.nasa.gov/image/129033)*

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
CASCADE Technologies, Inc.

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

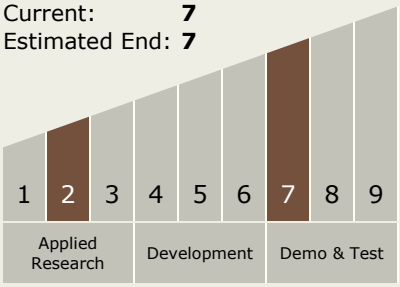
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Lee Shunn

Technology Maturity (TRL)

Start: **2**
Current: **7**
Estimated End: **7**



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Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.3 Cryogenic

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System